Answer on Question #44612 – Chemistry – Inorganic Chemistry

Question:

0.48 ml of 2-chloro-2-methylbutane is placed in 50 ml of 60/40 solvent of H2O/isopropanol. The following data is obtained from titration of 8.0 ml aliquots with 0.063 M NaOH. To all aliqouts, 6.0 mL of 99% isopropanol is added. Use the following data to determine the rate constant of the reaction.

Time (min) - Volume of NaOH (ml)
15 - 2.5

30 - 3.6

45 - 4.8

60 - 6.5

75 - 7.8

Answer:

According to the equation for the reaction rate:

r = K×[S],

where [S] – the concentration of 2-chloro-2-methylbutane which equals $[S_0]-[S_r]$ ($[S_0]$- the initial concentration, $[S_r]$ – the concentration of reacted 2-chloro-2-methylbutane.

$[S_0]$ can be found as follows: $[S_0] = \rho \times V/(M_w \times V(sol))$, where ρ –the density of 2-chloro-2-methylbutane, V – the volume of 2-chloro-2-methylbutane, M_w – the molar weight of 2-chloro-2-methylbutane and V(sol) – the total volume of the reaction mixture.

Thus, $[S_0]$ = 0.866 g/ml × 0.48 ml/(107 g/mole × (50 ml +0.48 ml)) = 0.0769 M

To find $[S_r]$, first of all, calculate the number of moles of used NaOH (N): N(NaOH) = [V(NaOH)/1000]× 0.063 M.

The N(NaOH) equals the amount of formed HCl which is of the amount of 2-chloro-2-methylbutane being reacted. The concentration of the product can be found according to the equation:

$[S_r]$ = C(HCl) = [(N(NaOH)/8 ml)×50.48 ml/50.48 ml] ×1000

All calculated data are summarized in the following table:

Time, min	Volume (NaOH), ml	N (NaOH), mole	[Sr], mol/l	r, micromol/(l min)	[S], mmol/l
			0	0	
15	2.5	0.0001575	0.0196875	1312.5	57.2125
30	3.6	0.0002268	0.02835	288.75	48.55
45	4.8	0.0003024	0.0378	210	39.1
60	6.5	0.0004095	0.0511875	223.125	25.7125
75	7.8	0.0004914	0.061425	136.5	15.475

Plotting the dependence of r on the $[S_r]$, the rate constant can be found using the trend line equation

$(y = A \times x + b)$. According to the equation $r = K \times [S]$, the coefficient **A** equals the rate constant.

Thus, the rate constant: $K = 3.818 \times 10^{-3}$ min^{-1}
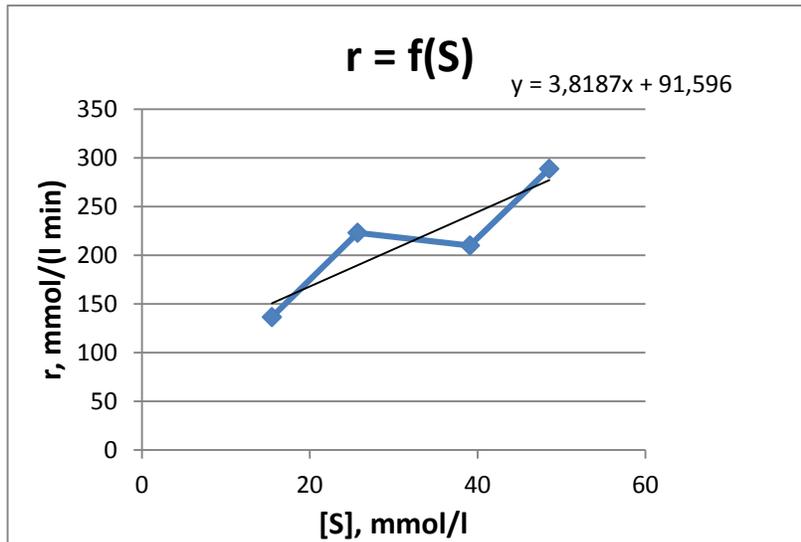
[**Note**: $r_i = ([S_r]_i - [S_r]_{i-1})/(t_i-t_{i-1})$

The first point at the [S] = 57.2125 mmol/l has not been included into calculation due to its significant deviation from the straight line.]